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EXXON CORPORATION

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R. E. LANDRY/Imperial Oil  
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MS.

Public Affairs Department

f.s.i.

To: Regional PA/PR/GR Managers

Subject: Oil Exploration In Developing Countries

In May, Exxon Producing and Corporate Planning jointly gave an oral presentation to staff members of various U.S. Government departments providing background on industry exploration activities in developing countries. This subject has received considerable interest recently in government circles.

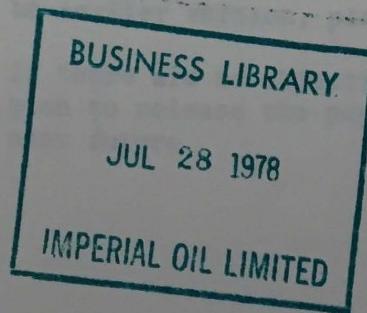
We are attaching copies of the presentation for your use on the following basis:

- (1) This material can be used with government officials.
- (2) The material can be given to the press at their request, but as background information only.
- (3) This material should not, at this time, be published or widely disseminated as an Exxon study.

We hope that this paper can be useful to you on this basis and would appreciate your advising us of any significant reactions to it by company or other readers.

*J. D. Whitelaw*  
J. D. Whitelaw

JDW/gw  
Att.



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*Please see what  
gatherings described  
remain with  
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# EXXON CORPORATION

1251 AVENUE OF THE AMERICAS, NEW YORK, N.Y. 10020



Producing Department  
DONALD K. McIVOR - Vice President

June 16, 1978

## EXPLORATION IN DEVELOPING COUNTRIES

### MEMBERS OF THE MANAGEMENT COMMITTEE

On May 16, in Washington, D.C., Producing and CPD jointly gave a verbal presentation of the attached paper "Exploration in Developing Countries." The audience included staff members of the Departments of State, Energy, and Treasury, along with members of the CIA and OPIC.

The presentation was made at the request of our Washington office in order to provide some background on exploration in developing countries. In particular it was hoped to provide some perspective on a subject that has been of considerable concern in government circles over the past several months. The verbal presentation appeared to be well received, and there have been numerous requests to release the text. These requests have come both from within and outside the Company.

In anticipation that it would be in Exxon's interest to release the text, we circulated it through the Law Department, and have incorporated their suggested changes. Changes suggested by Exxon Management have also been made. Should you have received an earlier version, please replace it with this copy.

If there are no objections to the text and illustrations, we plan to release the paper through Exxon Public Affairs in the near future.

*R.K. Steer*  
R. K. Steer  
For: D. K. McIvor

Attachment  
cc: N. Belknap  
S. Stamas

EXPLORATION IN DEVELOPING COUNTRIES

EXXON CORPORATION  
JUNE 1978

## INTRODUCTION

A number of recent studies concerned with the international energy environment have suggested that little oil exploration was occurring in the developing countries, and that an acceleration of exploration in these countries could lead to early substantial increases in non-OPEC production.

The following presentation is designed to provide some perspective on world oil exploration. It will indicate that a great deal of exploration has been done in the developing nations and that a very significant increase in oil production is anticipated from these areas.

PETROLEUM OCCURRENCE

- o Some initial perspective on the what is known and not known about the size of the world's petroleum resource base and where it might be found would appear to be a useful starting point.
- o At the recent World Energy Conference, the results of a poll of 29 "experts" on the size of the world's remaining oil and gas resource base were reported. The poll indicated that all the respondents believed considerable petroleum remains to be found, but that their estimates of how much vary over a wide range. The results of the poll are summarized on the first chart. The numbers shown are for oil alone, and are for the remaining resource base in the Communist and non-Communist world, including what has already been discovered but not produced.
  - The mean estimate for the remaining recoverable oil resource base was reported as 2.1 trillion barrels, of which 1.0 trillion, or about half, has already been discovered.
  - The mean of a small group of low estimates was reported as 1.2 trillion barrels, while the mean of a high group was reported as 3.0 trillion.
  - However, about two thirds of the estimates submitted fell within the 1.6 to 2.1 trillion range.
- o Estimates such as these are based on geologic data gathered for more than a century all over the face of the globe by a variety of techniques which are steadily improving with experience and time. The starting point is a study of all the sedimentary basins in which petroleum could exist.
  - On the order of 600 such basins have been identified worldwide, both on land and under the oceans, and sufficient work has been done in all to give an indication of their dimensions, the amount and general types of sediments, and their general structural aspects.

- In roughly 400 of these basins, exploration drilling has been done in varying amounts and with varying degrees of success.
  - About 160 of the basins in this group are now capable of producing commercial quantities of oil and gas. A very large amount of oil is judged to be yet discoverable in these 160 basins where the existence of oil has already been demonstrated. The World Energy Conference poll indicated that about 60% of the remaining discoveries were likely to be made in these already productive basins.
  - The other 240 partly explored basins have been drilled without yielding commercial discoveries to date. Statistically, perhaps 40 of these basins might eventually be found productive.
- The remaining 200 basins have had essentially no drilling as yet -- in most cases, because they are in harsh physical environments, or in a few cases, because of governmental restraints which have restricted access to them. Perhaps half of these may eventually prove productive. The potential of these basins is the most speculative part of the assessment, and the furthest in the future.
- Taken overall, it appears that about half the sedimentary basins of the world might eventually turn out to be productive of oil and gas, and that something over half of these are already productive.

PETROLEUM OCCURRENCEWORLD ENERGY CONFERENCE POLL

OIL RESOURCE BASE  
Trillion Bbls  
Remaining Recoverable

MEAN ESTIMATE	2.1
MEAN OF LOWS, HIGHS	1.2, 3.0
MAJORITY RANGE	1.6 - 2.1

GEOLOGIC OCCURRENCE

SEDIMENTARY BASINS  
Approximate No.

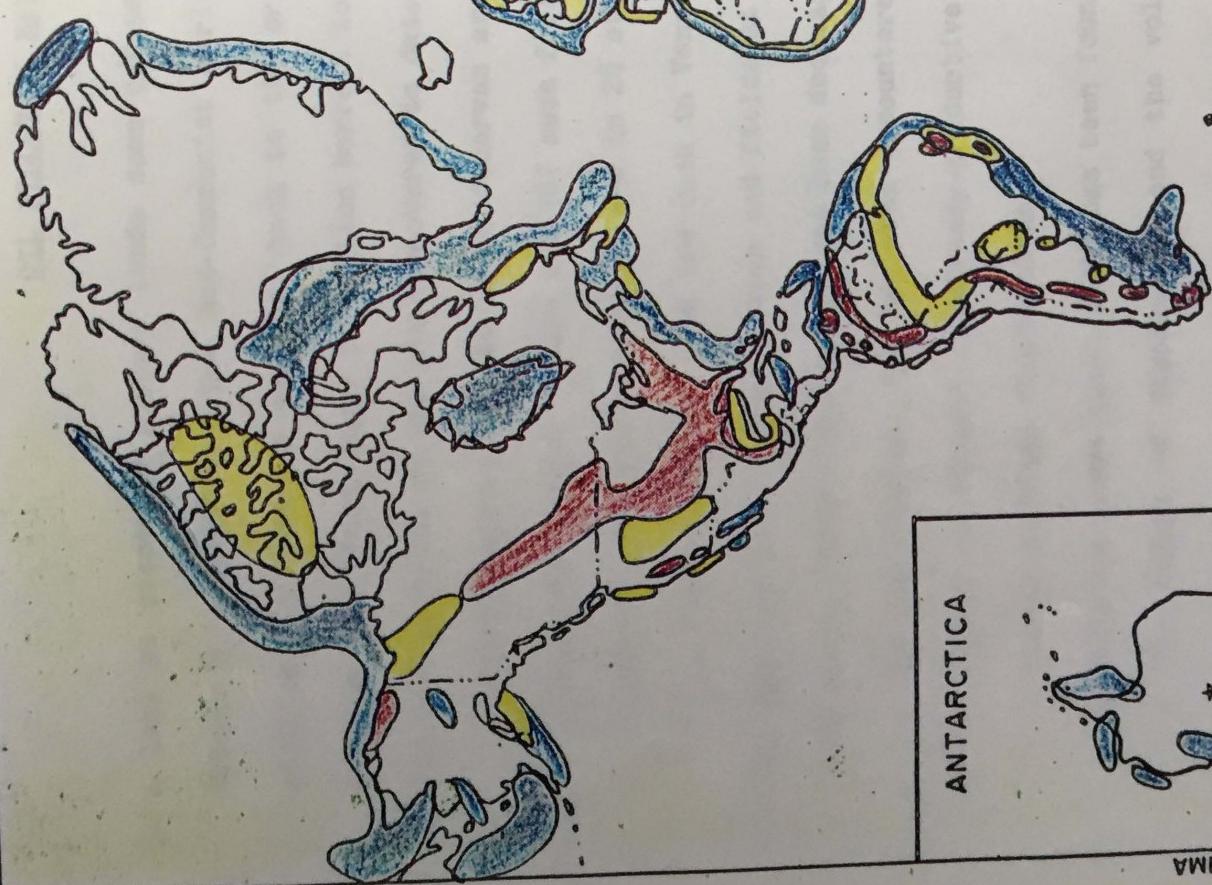
OIL/GAS MIGHT EXIST	600
DRILLED TO DATE	400
PRODUCTIVE	160
POSSIBLY PRODUCTIVE	40
UNEXPLORED	200
POSSIBLY PRODUCTIVE	100

PETROLEUM OCCURRENCE - 2

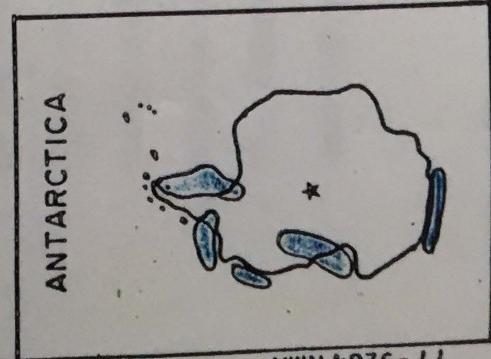
- o Here, the principal of these basins are shown on a map. (Please note this is a Mercator projection which exaggerates the scale of the areas toward the poles.)
  - The 160 basins now producing are shown in red on the chart. The geographic distribution of the reserves which have been discovered in these is very disproportionate, however: a mere 25 of the 160 basins contain 86% of the petroleum -- and just one of them -- the Persian Gulf basin -- by itself accounts for 40%. It is in these red areas that about 60% of the undiscovered potential is judged to lie.
  - The remaining 240 of partially explored basins are in areas shown in yellow. It can be seen that these are broadly distributed geographically, with a number in developing countries, and many in offshore areas where access has been relatively recent.
  - The 200 unexplored basins are generally in the blue areas. These are in harsh environments such as the deep water or Arctic areas, or are in the remote interior of lightly inhabited continents. A good many are in the developing countries.
  - The World Energy Conference poll estimated that roughly 40% of world's undiscovered potential is likely to be found in the unexplored (blue), and partially explored (yellow) areas where there is no production to date. Of this 40%, about one quarter is judged to be in moderately-harsh environments (such as Central Africa) and three-quarters in extreme environments, where exploration and development are at best very difficult and costly and where advanced technologies are a prerequisite.
- o Clearly, considerable oil remains to be found, but equally clearly, where and how much is a matter of speculation until exploration drilling occurs. The fact that different operators have different views of the total undiscovered potential, and of the potential of each specific area, enhances the dispersion of exploration activities, and that, in turn, improves the chances of making discoveries.

BASINS OF THE WORLD

PRODUCTIVE  
PARTIALLY EXPLORIED  
UNEXPLORIED



ANTARCTICA



77-9264 NMA

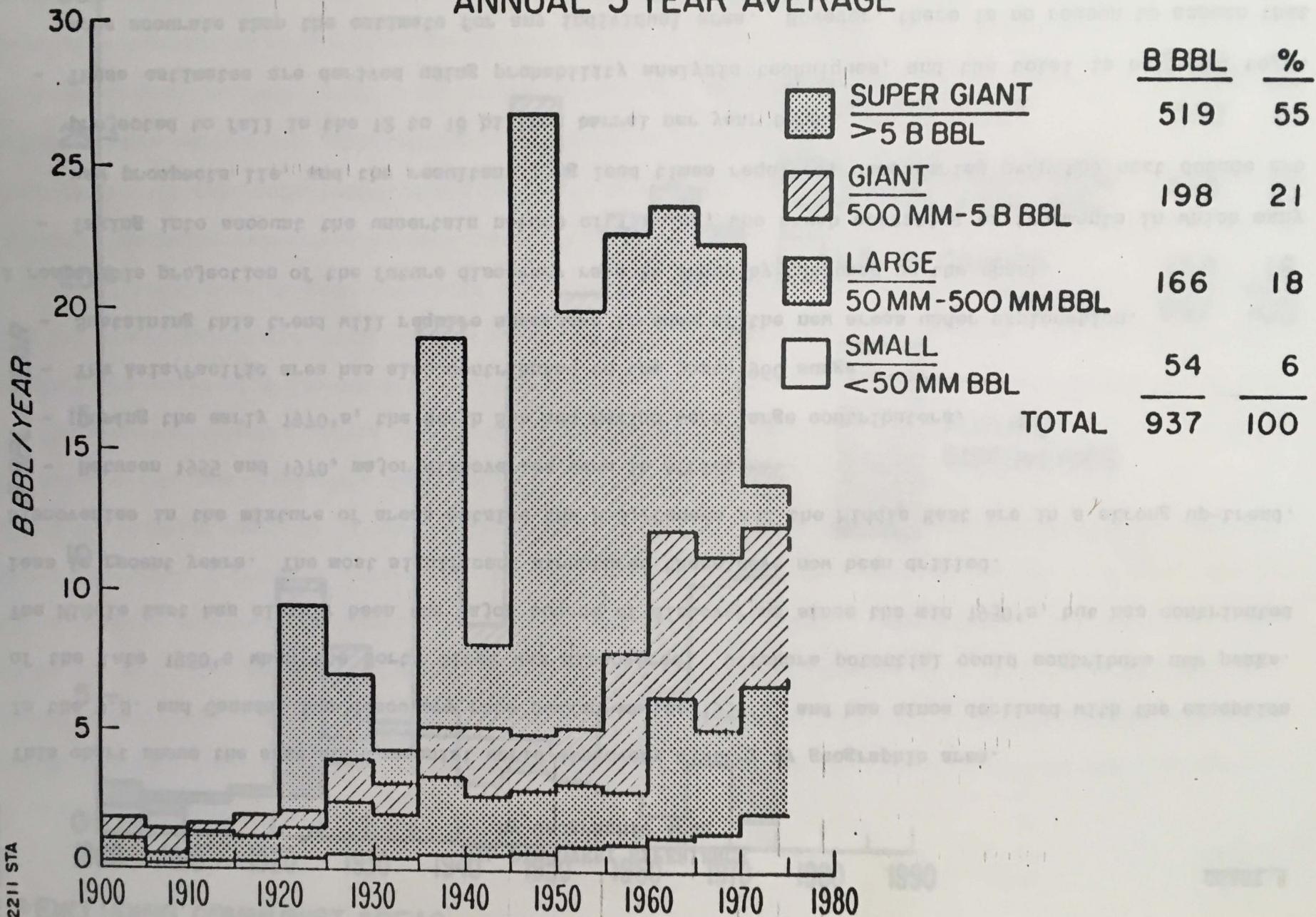
OIL DISCOVERY EXPERIENCE BY FIELD SIZE

- o A look at discovery history lends some perspective to trends in finding to date. The chart shows the discovery history for the non-Communist world averaged over five-year periods, with estimated future additions to reserves credited back to the original year of discovery. History is shown by field size, ranging from fields under 50 million barrels to those over 5 billion barrels.
- o The vast majority of the oil discovered to date has been in large fields.
  - Three-quarters of the known reserves are in super-giant and giant fields, each containing over 500 million barrels. There are 187 such fields located in twenty-odd basins.
  - Half of the known reserves are in 28 super-giants with over 5 billion barrels each; 24 of these are in the Middle East, and one each in Venezuela, Mexico, Texas and the North Slope.
- o Oil has been found in new basins and fields at a fairly steady rate in the past, but the share of discoveries made in the larger field sizes has been decreasing.
  - On the average, oil has been encountered in about 4 new basins, and in 5 new groups of productive fields or "plays" in already-productive basins, in each year since the mid-1950's, with only relatively moderate fluctuations.
  - Only one super-giant field has been found since the late 1960's (in Mexico).
  - The number of discoveries and the volume of reserves found in smaller fields (under 50 million barrels) has been steadily increasing.

- o The facts that only one super-giant field has been discovered since the late 1960's, and that the finding rate for the smallest fields has increased, reflect several factors:
  - Few of the basins which have been explored in recent years have contained structures where super-giant fields might be found, and none of the unexplored basins appear to have the geologic characteristics required for a series of super-giants. Thus, the prospects of finding another Middle East would appear to be nil.
  - The largest and best structural prospects in a basin are explored first, and the early discoveries in any given basin usually include the largest fields. As a consequence, the size of the remaining prospects in that basin generally decreases as exploration proceeds.
  - The already productive basins are progressively being more intensely explored over time; as a result, smaller fields are tending to become the prime exploration targets. With more basins moving into the intensely explored category, the number of smaller finds naturally increases.
  - Improvements in exploration technology have enhanced the explorationists' ability to find smaller fields. Moreover, as the infrastructure has developed in the known producing areas, and as prices have increased, the economics of developing smaller fields have improved. But the cumulative volume found in these fields is small as can be seen at the bottom of the chart.

# WORLD\* OIL DISCOVERY HISTORY - BY FIELD SIZE

## ANNUAL 5 YEAR AVERAGE



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\* EXCLUDING COMMUNIST AREAS

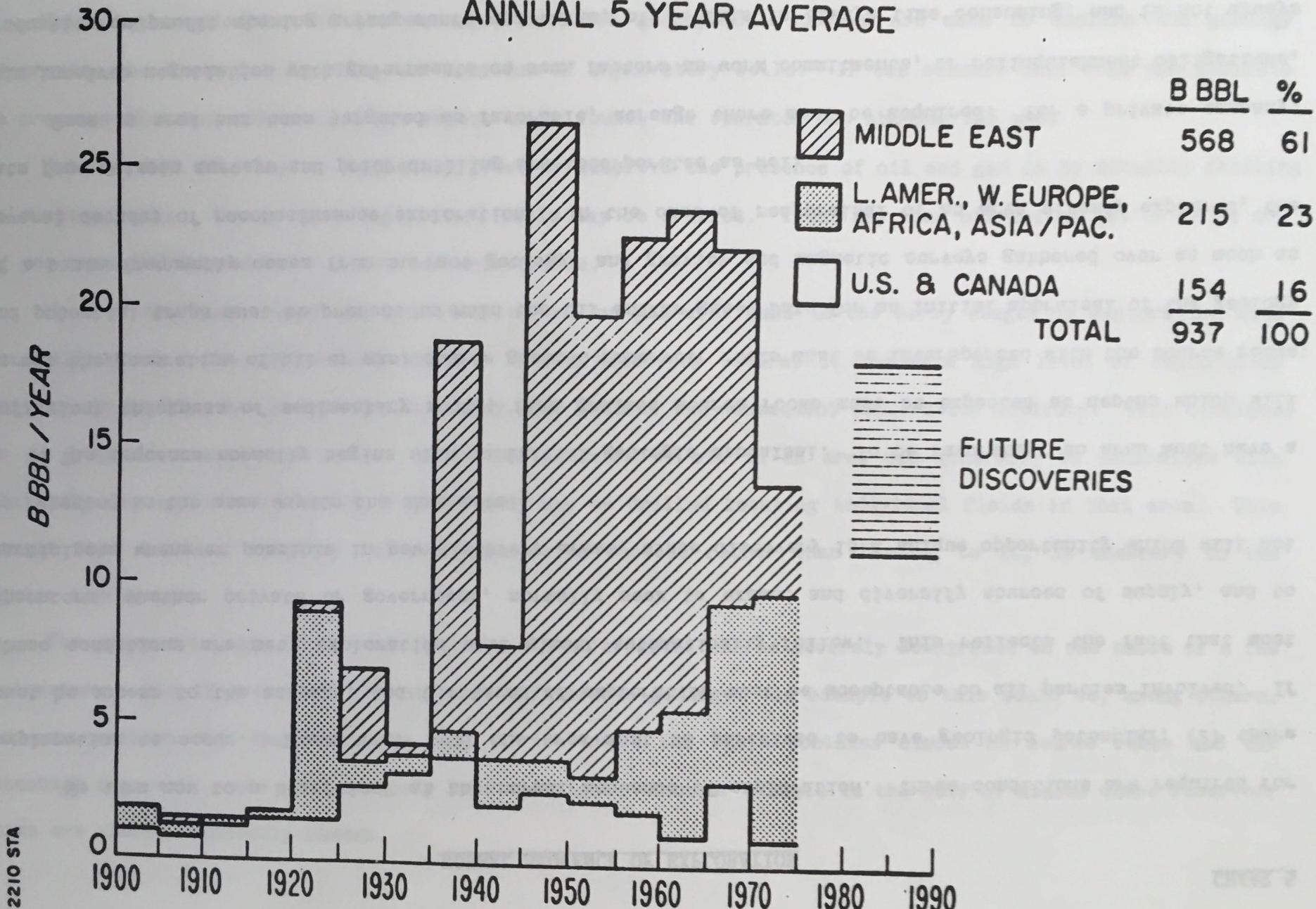
OIL DISCOVERY EXPERIENCE

By Geographic Area

- o This chart shows the same non-Communist world discovery history by geographic area.
- o In the U.S. and Canada, the discovery rate peaked in the 1930's, and has since declined with the exception of the late 1960's when the North Slope was discovered. Offshore potential could contribute new peaks.
- o The Middle East has clearly been the major source of discoveries since the mid 1930's, but has contributed less in recent years. The most significant structures there have now been drilled.
- o Discoveries in the mixture of areas outside the U.S./Canada and the Middle East are in a strong up-trend.
  - Between 1955 and 1970, major discoveries were in Africa.
  - During the early 1970's, the North Sea and Mexico were large contributors.
  - The Asia/Pacific area has also contributed to the post-1960 surge.
  - Sustaining this trend will require successes in some of the new areas under exploration.
- o A reasonable projection of the future discovery rate is shown by the band on the chart.
  - Taking into account the uncertain nature of finding, the harsh operating environments in which many new prospects lie, and the resultant long lead times required, discoveries over the next decade are projected to fall in the 12 to 18 billion barrel per year band.
  - These estimates are derived using probability analysis techniques, and the total is believed to be more accurate than the estimate for any individual area. However, there is no reason to assume that significant future discoveries will not be made in all major geographic regions. Later a production estimate for the developing nations will be shown.

# WORLD\* OIL DISCOVERY HISTORY

## ANNUAL 5 YEAR AVERAGE



\* EXCLUDING COMMUNIST AREAS

NORMAL SEQUENCE OF EXPLORATION

We turn now to a brief look at the normal sequence of exploration. Three conditions are required for exploration to occur. These are: (1) the area must be perceived to have geologic potential; (2) there must be access to the acreage; and (3) terms of exploration must be acceptable to all parties involved. If these conditions are met, exploration will almost automatically follow. This reflects the fact that most operators, whether private or government, normally seek to expand and diversify sources of supply, and to participate whenever possible in new discovery areas, since discovery is a unique opportunity which will not be repeated in the same way in the same area.

The sequence normally begins with an initial geologic appraisal. To be favorable, an area must have sufficient thickness of sedimentary rocks; fine grained source rocks must be expected at depths which will permit the generation of oil or gas; coarse grained reservoir rocks must be interspersed with the source rocks and potential traps must be present to hold the oil and/or gas. Data for an initial appraisal of the geology of a basin frequently comes from surface geology, and gravity and magnetic surveys gathered over as much as several decades of reconnaissance exploration. In the case of reappraisal of an area already explored, data from seismic surveys and prior drilling are incorporated as well.

Once an area has been targeted as favorable, acreage there must be acquired. For a private company this involves negotiation with governments on such factors as work commitments, or relinquishment obligations, production or profit sharing arrangements and taxes, etc. This is always time consuming, and is not always successful.

Following acquisition of the acreage, detailed geophysical surveys are made to confirm the geology and provide the basis for deciding the location of exploratory wells. If the seismic data does not indicate the presence of traps where oil might expect to be found, the operator may abandon the area.

However, the only way to completely prove or disprove the presence of oil and gas is by actually drilling exploratory wells. One or more exploratory wells may be drilled. These may find oil and/or gas -- or be dry and yet somewhat favorable -- or dry and unfavorable.

Most of the time, major accumulations of oil or gas are found in the early stages of exploration with the drilling of a few exploratory wells. When a discovery occurs, it sparks a high level of exploration activity; typically, the larger the discovery, the greater the subsequent exploration activity. This continues for as long as success continues. While the presence of oil in an area can generally be determined with relatively few exploratory wells, a great many may be drilled locating individual fields in that area. This concept that drilling activity follows exploration success rather than leading to it, is contrary to the popular impression.

The prospectiveness of an area (part or all of a basin) can be severely downgraded on the basis of a few exploratory wells if these are dry and show unfavorable geology. An example of this would be, among others, the area onshore Mali-Mauritania in West Africa where the basin contains almost no source rocks and the potential reservoir rocks are extremely hard and tight. Another example is the Gulf of Alaska where reservoir rocks are almost completely absent.

If the geology continues to appear favorable even though the initial exploratory drilling does not find oil and gas, the exploration process may be reformulated. Either the same operator or another operator may immediately, or at a later date, use the results of prior work plus data from additional seismic surveys and exploration wells to reevaluate the area. Success on second, third, and later rounds is fairly rare, but does occur. This usually results from improved technology in seismic methods, either in data gathering analysis or from re-interpretation of the geologic setting. If results are unsuccessful, the property may be farmed out to other operators with different ideas, or dropped altogether.

Although the larger fields in any given area are searched for first and usually found earlier, this does not indicate a lack of interest in small fields. It merely reflects the fact that the economic development of small fields is often dependent on the discovery of the larger fields and the infrastructure created by them. Economics depend on producing rate, and cost factors such as location and depth, as well as on size.

## NORMAL SEQUENCE OF EXPLORATION

- INITIAL GEOLOGIC APPRAISAL
- ACCESS TO ACREAGE
- GEOPHYSICAL SURVEYS CONDUCTED
- WILDCAT LOCATIONS SELECTED AND DRILLED
  - FOLLOW-UP DRILLING
  - EXPLORATION PLANS REFORMULATED
  - ACREAGE PUT UP FOR FARMOUT, OR DROPPED

EXPLORATORY DRILLING  
(Except U.S., Canada and Communist Countries)

During the 1967-1976 decade a total of some 12,959 exploratory wells were drilled in the world outside of the U.S.A., Canada and Communist countries.\* About 24% were drilled in the industrial countries, i.e., Europe, Australia, and Japan, and 26% were drilled in the OPEC nations. The other half were drilled in the developing countries.

Both the level of total exploratory drilling, and the shares drilled in the industrial countries, OPEC countries and developing countries remained about the same throughout the decade. However, there were some important shifts between countries within each group. Many geologically prospective areas were tested; some successfully, many unsuccessfully. For cost and technology reasons, the most readily accessible prospects were tested first, and as a result, exploration has progressively moved into ever harsher environments--the deeper offshore and more remote continental interiors--where the time to position and drill a well is much longer and the cost much higher. For example, onshore wells in mature producing areas may cost up to \$100,000; similar wells in the interior of Africa and Latin America may now cost \$3-5 million; and wells located offshore in deep water can cost \$20 million or more. While oil prices have increased considerably during the past several years of the decade, producers' profit margins have grown relatively little due to cost inflation and higher government take.

Exploratory drilling alone does not give a complete picture of exploration activity, so one must also look at other activities such as seismic surveys. Both the extent and the intensity of the total exploration effort in the developing countries have been examined.

\*Data Source: American Association of Petroleum Geologists and Oil & Gas Journal.

EXPLORATORY WELLS DRILLED  
 EX U.S., CANADA AND COMMUNIST AREAS  
 1967-1976

	<u>NO. OF WELLS</u>	<u>%</u>
INDUSTRIAL COUNTRIES	3,145	24
OPEC	3,313	26
DEVELOPING COUNTRIES	<u>6,501</u>	<u>50</u>
	12,959	100

EXTENT OF EXPLORATION ACTIVITY IN NON-OPEC DEVELOPING COUNTRIES

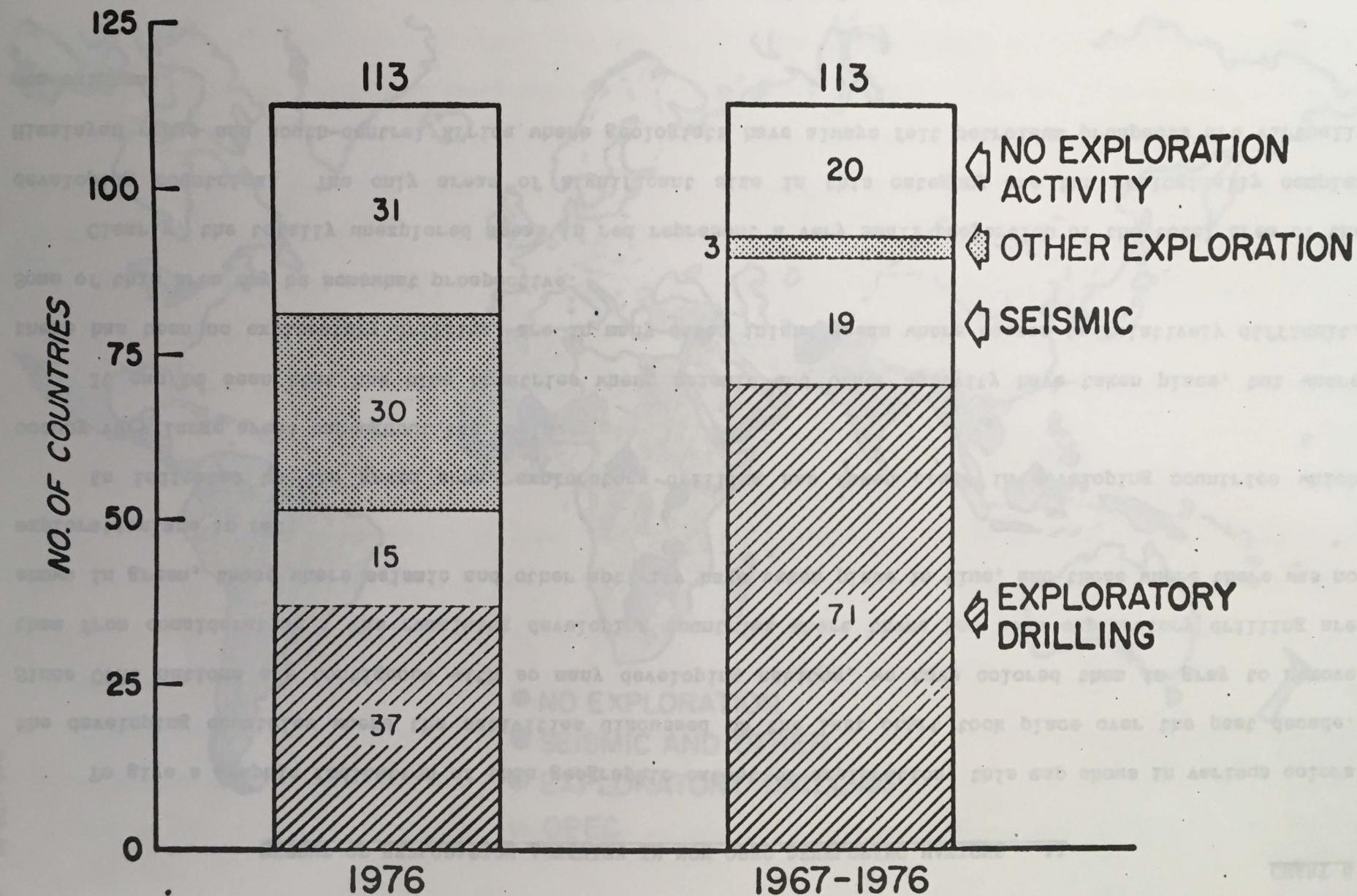
The chart shows the extent of all exploration activity in the developing countries for the year 1976 and for the 1967-76 decade as a whole. Exploration activity is broken down into drilling, seismic surveys and a catchall of "other" exploration. This latter is indicated by acreage in force. Since this generally requires a work commitment and has rentals or short term relinquishment provisions, the amount of acreage indicates interest and some form of activity.

Drilling and seismic activity during any one year is less extensive than for the decade as a whole, because not all areas are worked simultaneously. Some countries are abandoned after unsuccessful drilling, sometimes temporarily, and in others, government policies or various other factors may preclude exploration operations at a given point in time.

By one count, there are 113 developing countries and semi-independent territories in the world, excluding U.S., Canada, Western Europe, Australia, Japan and the Communist areas. In 1976, the most recent year for which data are available, exploratory drilling took place in 37 of these countries. Detailed seismic surveys but no drilling took place in 15. Other exploratory activity -- as indicated by acreage holdings -- took place in 30 countries. 31 countries saw no activity in that year. This latter group of countries does not represent a very significant amount of surface area and is, to a large extent, made up of countries with poor geologic prospects. However in some, activity was inhibited by governmental policies or uncertainties.

During the full decade, exploratory wells were drilled in 71 countries. Another 19 were explored by seismic surveys without drilling, and 3 countries were explored by other means. Only 20 countries were not explored at all. These 20 are mostly small island nations or are countries where geologic prospects are poor.

# EXTENT OF EXPLORATION ACTIVITY IN NON-OPEC DEVELOPING COUNTRIES



EXTENT OF EXPLORATION ACTIVITY IN NON-OPEC DEVELOPING NATIONS - 11

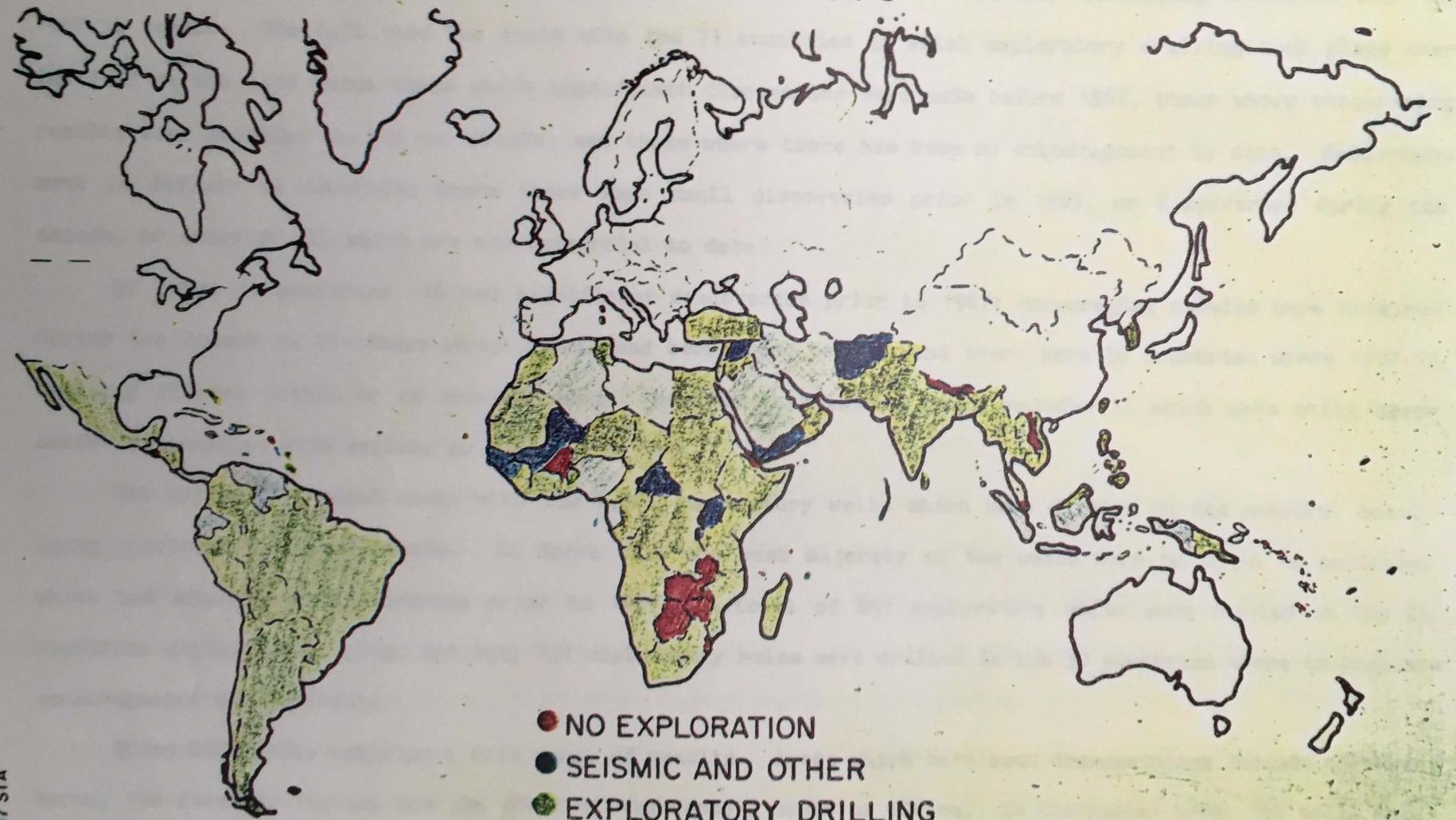
To give a graphic indication of this geographic extent of exploration, this map shows in various colors the developing countries where the activities discussed on the last chart took place over the past decade. Since OPEC nations are contiguous with so many developing nations, we have colored them in gray to remove them from consideration. The remaining developing countries where there has been exploratory drilling are shown in green, those where seismic and other activity have taken place in blue, and those where there was no exploration are in red.

As indicated by the green area, exploratory drilling has taken place in developing countries which occupy very large areas throughout the world.

It can be seen that the blue countries where seismic and other activity have taken place, but where there has been no exploratory drilling, are in many cases inland areas where access is relatively difficult. Some of this area may be somewhat prospective.

Clearly, the totally unexplored areas in red represent a very small proportion of the total area of the developing countries. The only areas of significant size in this category are the geologically complex Himalayan range and south-central Africa where geologists have always felt petroleum prospects are virtually non-existent.

EXTENT OF EXPLORATION ACTIVITY  
IN NON-OPEC DEVELOPING COUNTRIES  
YEARS 1967-1976



INTENSITY OF EXPLORATORY DRILLING IN THE NON-OPEC DEVELOPING COUNTRIES

This chart examines the intensity of exploratory drilling in the non-OPEC developing countries over the 1967-76 decade. The left hand bar deals with the 71 countries in which exploratory drilling took place over the full decade, and shows those where significant discoveries were made before 1967, those where encouraging results were obtained during the decade, and those where there has been no encouragement to date. Encouragement is defined as countries where there were small discoveries prior to 1967, or discoveries during the decade, or shows of oil which are non-commercial to date.

Of these 71 countries, 16 had significant discoveries prior to 1967; encouraging results were obtained during the decade in 25 others where no oil had been found before; and there were 30 countries where 1967-76 drilling yielded little or no encouragement. However this latter group includes 11 which were still under active exploration with seismic or drilling in 1976.

The bar at the right deals with the 6,501 exploratory wells which were drilled in the non-OPEC developing countries over the decade. It shows that the vast majority of the wells were in those 16 countries which had significant discoveries prior to 1967. A total of 851 exploratory wells were drilled in the 25 countries called encouraging, and only 234 exploratory holes were drilled in the 30 countries where no positive encouragement was indicated.

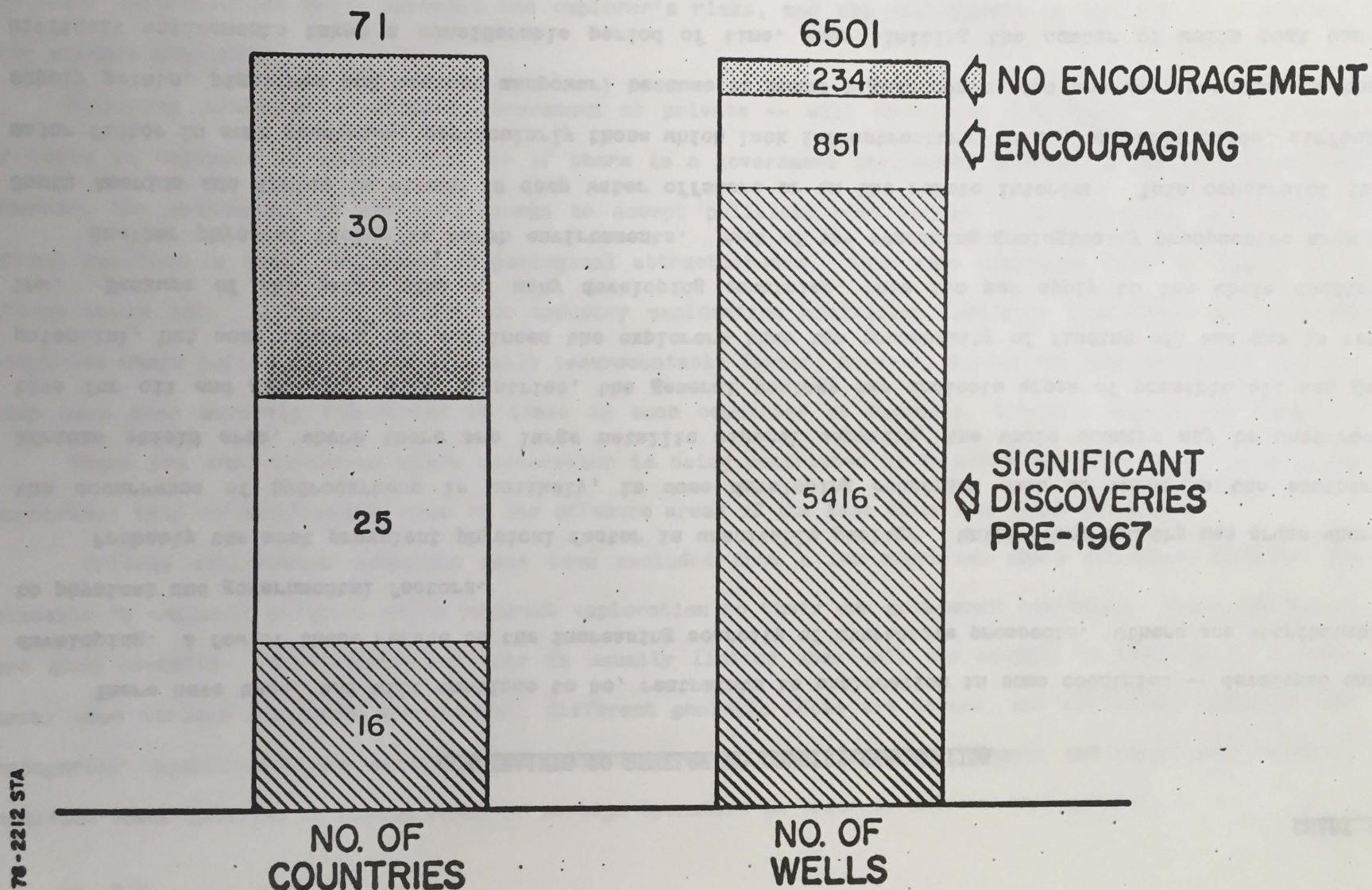
These 6500 wells comprise a wide range of results. Areas which have been disappointing include offshore Burma, the Peruvian Montana and the shelf of the western coast of Africa. In the latter area, 167 wells were drilled to test many structures, but very little oil was found, and as a consequence exploration activity is

now much decreased. On the other hand, important basin discoveries were made in countries such as Chad, Cameroon, Congo, and offshore Vietnam.

Records indicate that over 167 companies, both private and government, were involved in exploratory drilling in the non-OPEC developing countries during 1976.\* The data in the right hand column confirm that these companies view the most attractive exploration drilling areas as those regions where the presence of hydrocarbons has already been established. However, a wide diversity of opinion is evident in the diversification of countries selected by various companies, and this in turn enhances the number of prospects tested.

\*Data Source: Petroconsultants Ltd.

INTENSITY OF EXPLORATORY DRILLING  
IN NON-OPEC DEVELOPING COUNTRIES  
YEARS 1967-1976



CONSTRAINTS TO DEVELOPING COUNTRY EXPLORATION

There have been, and will continue to be, restraints to exploration in some countries -- developed and developing. A few of these relate to the increasing scarcity of attractive prospects. Others are attributable to physical and governmental factors.

Probably the most prevalent physical factor is unsuitable geology. While every country has areas where the occurrence of hydrocarbons is unlikely, in some developing countries such as those in the southern African shield area, where there are large metallic mineral deposits, the whole country may be unattractive for oil and gas. In other countries, the general geology may indicate areas of possible oil and gas potential, but some testing has convinced the explorers that the probability of finding oil and gas is very low. Because of the small size of many developing countries, this too may apply to the whole country.

Another physical factor is harsh environments. Much of the remaining geologically prospective area in South America and Africa is either in deep water offshore or in the remote interior. This constraint is a major factor in some countries, particularly those which lack infrastructure, (i.e., suitable roads, airfields, supply points, pipelines and trained manpower) because it means higher costs, and because operating in these difficult environments takes a considerable period of time, thus limiting the number of wells that can be drilled.

It should be emphasized that the prospect of small discoveries is not a factor which inhibits exploration at the initial stage, because this is still one of the unknowns at that point in time.

#### GOVERNMENTAL RESTRAINTS TO EXPLORATION

Governmental restraints to exploration -- which can apply to both private and state companies -- include political uncertainties which increase the explorer's risks, and the willingness or ability of a country to make acreage available.

Exploring companies -- whether government or private -- will have some reluctance to enter a country if there is evidence of instability, or if there is a government philosophy hostile to foreign enterprise. However, the assessment of and willingness to accept political risk varies among companies, apparently in direct relation to their estimates of geological attractiveness. Thus some companies enter a country where others would not. A survey of current industry exploration activities indicates that there are very few countries where political risk is a totally insurmountable factor; however, during the past ten years exploration have been severely restricted at times in such countries as Cambodia, Vietnam, Angola and Tanzania.

There are some instances where exploration is being restricted by boundary disputes between neighboring countries; this is particularly true in the offshore areas of the East China and South China seas.

Private exploration companies have been excluded from a few countries where petroleum reserves are sizeable by national policies which restrict exploration to their own government companies. India and Mexico are good examples. Exploration activity is usually limited when only one company is involved in a large area; when various companies are present, different geologic ideas are tested, and additional technical and managerial capabilities are applied. It should be noted that Argentina, Brazil and Chile have recently modified their policies to permit entry of foreign operators in order to attract exploration.

Private companies often may have difficulty negotiating terms which they consider are compatible with the investment risk they are taking; however, while difficult and time-consuming, these negotiating problems normally can be resolved. Malaysia is a recent example where this has occurred.

In general, government constraints can limit the access to acreage in a particular area at a particular time. This is true in industrially developed countries as well as the developing nations. Availability of acreage is a major factor in determining the number of companies exploring as well as the overall level of activity. Over time, however, these constraints tend to be resolved and exploration proceeds.

# MILLION BARRELS/DAY (INCL. NGL)

CHART 10

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## CONSTRAINTS TO DEVELOPING COUNTRY EXPLORATION

### PHYSICAL

### UNSUITABLE GEOLOGY

### HARSH ENVIRONMENT

### GOVERNMENTAL

### POLITICAL UNCERTAINTIES

### AVAILABILITY OF ACREAGE

1976

1980

1985

OTT BUDGETING IN DEVELOPING COUNTRIES

1990

OIL PRODUCTION IN DEVELOPING COUNTRIES

This projection of oil production in the developing countries is based on the assumptions that some of the government uncertainties and acreage access constraints will gradually ease and that physical problems will be at least partially overcome by improved technology, albeit slowly and at considerable cost. Even so, lead times on the order of 6-12 years from initial discovery to development of commercial production are anticipated in currently non-productive areas.

This chart shows a rapid growth in production for these countries, as a result of past and future exploration -- from a level of 4 MMB/D in 1976 to 10 MMB/D in 1990. Some growth occurs in all geographic regions. The most rapid acceleration is projected to be in Latin America, with Mexico, which has already had significant discoveries in recent years, being an important component of this.

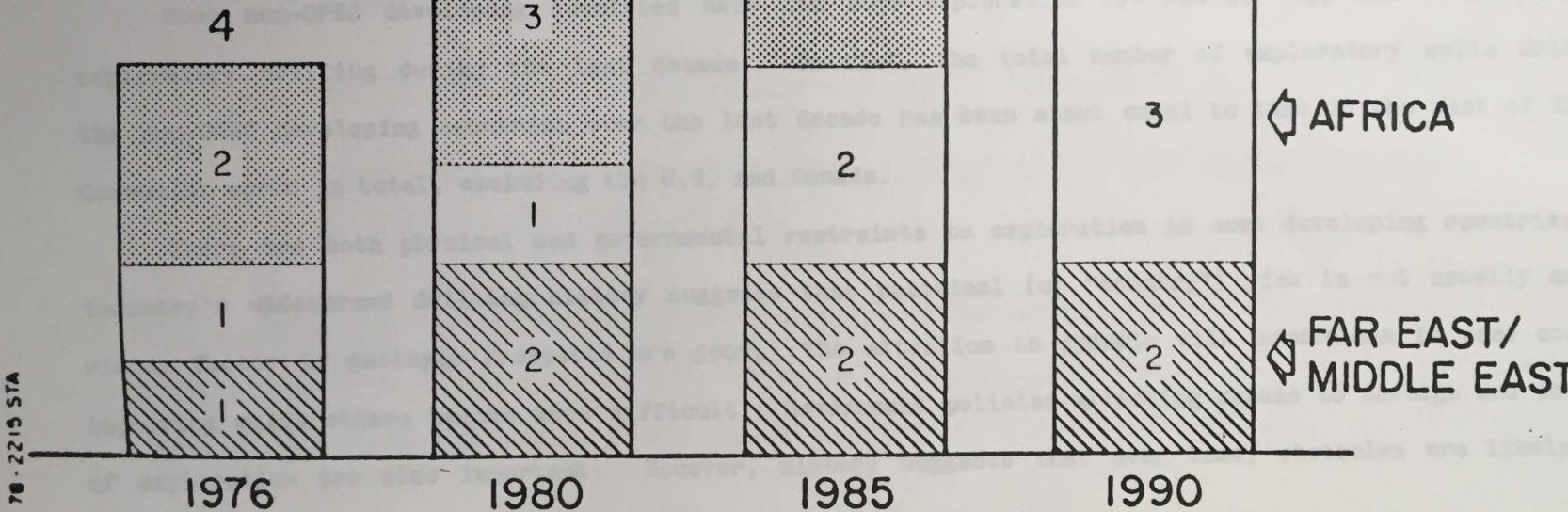
Overall, this rapid rate of growth is in contrast with some other areas where production is projected to be more static during this period, in part, because production from previously discovered fields will be in decline. The projected 1985/1990 production level of 8/10 MMB/d in developing countries will be a significant part of total world supply at that time. In 1990, this amounts to about 14% of total free world production, and to one-third of free world production when that required from the OPEC nations is excluded.

Of the total free world oil consumption in 1990, more than one-quarter may come from reserves yet to be discovered. The developing countries are expected to account for about one third of this new discovery oil. It is not possible to predict where these discoveries will occur since it is based on a probability assessment of the undiscovered resource base. But it is clear that significant quantities of undiscovered oil and gas are believed to exist in the developing countries.

# DEVELOPING COUNTRIES OIL SUPPLY

## MILLION BARRELS/DAY (INCL. NGL)

There are diverse influences on where and how much additional petroleum can be extracted geographically. Exploration is being forced into areas where oil has not been present, relatively few wildcat wells are usually required to find oil. The larger fields in a new area usually appear early and many more wildcat wells are drilled to find additional fields in a new area. The larger fields are usually discovered first and the larger fields are most often discovered first. This is true regardless of whatever other factors may exist in a developing country.



## CONCLUSIONS

There are diverse judgments on where and how much additional petroleum can be found. It is very unevenly distributed geographically. Exploration is being forced into harsher environments.

The exploration process is geologic analysis followed by drilling. If significant oil and gas are present, relatively few wildcat wells are usually required to establish this fact. The initial discovery in a new area usually sparks activity and many exploratory wells are then likely to be drilled to search for additional fields in a new area. The largest structures on the available acreage are normally drilled first, and the larger fields are most often discovered early in the exploration cycle. However, the companies will develop whatever sized reserves they find as long as it is economic to do so. Small fields can be important to a developing country and, cumulatively, to the diversity and total size of a company's (and the world's) reserves.

Most non-OPEC developing countries have had some exploration (94 out of 113) and 71 have had some exploratory drilling during the last decade. In fact, the total number of exploratory wells drilled in the non-OPEC developing countries over the last decade has been about equal to that in the rest of the non-Communist world in total, excluding the U.S. and Canada.

There are both physical and governmental restraints to exploration in some developing countries. The industry's widespread drilling history suggests that political (or "country") risk is not usually an overriding factor if geologic prospects are good. The situation is dynamic with conditions in some countries improving while others become more difficult. Government policies affecting access to acreage and the terms of exploration are also important. However, history suggests that over time, obstacles are likely to be resolved.

Exploration success has been and will likely continue to be irregular, and results are very uncertain. Nevertheless, production in the developing countries is projected to increase in the future -- from 4 MMB/D in 1976 to 10 MMB/D in 1990, assuming governmental restraints do not preclude the activities required.

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## CONCLUSIONS

- SIGNIFICANT UNDISCOVERED RESOURCE BASE IN DEVELOPING AND OTHER AREAS.
- FEW WELLS NEEDED TO MAKE INITIAL DISCOVERY, FIRST DISCOVERIES SPARK ACTIVITY.
- MOST DEVELOPING COUNTRIES HAVE HAD SOME EXPLORATION.
- GOVERNMENTAL CONSTRAINTS IMPORTANT, BUT USUALLY NOT OVERRIDING LONG TERM.
- SUBSTANTIAL INCREASE IN PRODUCTION PROJECTED IN DEVELOPING COUNTRIES.

EXPLORATION ACTIVITY IN NON-OPEC  
DEVELOPING COUNTRIES

KEY: X Seismic took place or acreage in force.

DATA SOURCES: American Association of Petroleum Geologists, Oil and Gas Journal, Petroconsultants and Society of Exploration Geophysicists.

Country	Year 1976			1967-1976			<u>Results of Drilling</u>
	Exploratory Wells	Seismic	Acreage	Exploratory Wells	Seismic	Acreage	
<u>LATIN AMERICA</u>							
1. Argentina	83	X		1060	X	X	<u>Discovery since 1907</u>
2. Bahamas	0	0	X	2	X	X	No Encouragement
3. Barbados	0	0	X	3	X	X	Small Disc.
4. Belize	0	X	X	14	X	X	No Encouragement
5. Bolivia	16	X	X	127	X	X	<u>Disc. since 1927</u>
6. Brazil	105	X		934	X		<u>Disc. since 1941</u>
7. Chile	22	X		221	X		<u>Disc. since 1954</u>
8. Colombia	21	X	X	201	X	X	<u>Disc. since 1918</u>
9. Costa Rica	0	0	0	1	X	X	No Encouragement
10. Dominican Republic	0	0	0	9	X	X	No Encouragement
11. French Guiana	0	X	X	1	X	X	No Encouragement
12. Guatemala	5	X	X	13	X	X	Small Disc.
13. Guyana	0	0	X	12	X	X	No Encouragement
14. Haiti	0	0	X	0	X	X	No Encouragement
15. Honduras	0	X	X	9	X	X	No Encouragement
16. Jamaica	0	0	0	2	X	X	No Encouragement
17. Leeward & Windward Islands	0	0	X	0	X	X	No Encouragement
18. Mexico	77	X		1190	X		<u>Disc. since 1900</u>
19. Netherlands Antilles	0	0	X	0	X	X	No Encouargement
20. Nicaragua	0	X	X	24	X	X	No Encouragement
21. Panama	0	X	X	2	X	X	No Encouragement
22. Paraguay	1	X	X	22	X	X	No Encouragement
23. Peru	36	X	X	351	X	X	<u>Disc. since 1869</u>
24. Puerto Rico	0	0	X	0	X	X	No Encouragement
25. Surinam	0	X	X	31	X	X	No Encouragement
26. Trinidad & Tobago	23	X	X	203	X	X	No Encouragement
27. Uruguay	2	X	X	2	X	X	<u>Disc. since 1902</u> No Encouragement

EXPLORATION ACTIVITY IN NON-OPEC  
DEVELOPING COUNTRIES

Country	Year 1976			1967-1976			Results of Drilling
	Exploratory Wells	Seismic	Acreage	Exploratory Wells	Seismic	Acreage	
<u>AFRICA</u>							
28. Angola	5	X	X	222	X	X	<u>Disc. since 1962</u>
29. Benin (Dahomey)	0	X	X	11	X	X	No Disc. (shows)
30. Burundi	0	0	0	0	X	X	No Encouragement
31. Cameroon	7	X	X	41	X	X	Disc. 1972
32. Central African Empire	0	0	X	0	0	X	No Encouragement
33. Chad	4	X	X	12	X	X	Disc. 1974
34. Congo	0	X	X	26	X	X	Disc. 1969
35. Egypt	34	X	X	213	X	X	<u>Disc. since 1938</u>
36. Equatorial Guinea	0	0	X	7	X	X	No Encouragement
37. Ethiopia	0	0	X	14	X	X	No Encouragement
38. Gambia	0	0	X	0	X	X	No Encouragement
39. Ghana	0	X	X	22	X	X	No Disc. (shows)
40. Guinea	0	0	X	0	X	X	No Encouragement
41. Guinea-Bissau	0	0	0	6	X	X	No Encouragement
42. Ivory Coast	1	X	X	8	X	X	Small Disc.
43. Kenya	2	X	X	8	X	X	No Encouragement
44. Lesotho	0	0	0	1	0	X	No Encouragement
45. Liberia	0	0	X	4	X	X	No Encouragement
46. Malagasy	0	0	X	17	X	X	No Encouragement
47. Mali	0	0	X	0	X	X	No Encouragement
48. Mauritania	0	0	X	12	X	X	No Encouragement
49. Mauritius	0	0	0	0	X	X	No Encouragement
50. Morocco (incl. Sp. Sahara)	8	X	X	75	X	X	Small Disc.
51. Mozambique	0	0	0	36	X	X	No Disc. (shows)
52. Niger	0	0	X	6	X	X	No Disc. (shows)
53. Sao Tome & Principe	0	0	X	0	X	X	No Encouragement
54. Senegal	2	0	X	26	X	X	No Disc. (shows)
55. Sierra Leone	0	0	0	0	X	X	No Encouragement

EXPLORATION ACTIVITY IN NON-OPEC  
DEVELOPING COUNTRIES

<u>Country</u>	<u>Year 1976</u>			<u>1967-1976</u>			<u>Results of Drilling</u>
	<u>Exploratory Wells</u>	<u>Seismic</u>	<u>Acreage</u>	<u>Exploratory Wells</u>	<u>Seismic</u>	<u>Acreage</u>	
<b>AFRICA (continued)</b>							
56. Somalia	1	0	X	7	X	X	No Disc. (shows)
57. South Africa	8	X	X	92	X	X	No Disc. (shows)
58. Namibia (SW Africa)	0	X	X	4	X	X	No Encouragement
59. Sudan	2	X	X	3	X	X	No Encouragement
60. Tanzania	3	0	X	5	X	X	(possible disc. 1977)
61. Togo	0	0	0	3	X	X	No Encouragement
62. Tunisia	10	X	X	93	X	X	No Encouragement
63. Uganda	0	0	X	0	0	X	<u>Disc. since 1964</u>
64. Zaire	2	0	X	29	X	X	No Encouragement
<b>MIDDLE EAST</b>							
65. Bahrain	0	0	X	0	X	X	<u>Disc. since 1932</u>
66. Cyprus	0	0	X	2	X	X	No Encouragement
67. Israel (ex Sinai)	8	X	X	59	X	X	Small Disc.
68. Jordan	0	0	X	6	X	X	No Encouragement
69. Lebanon	0	0	X	1	X	X	No Encouragement
70. Oman	0	X	X	28	X	X	<u>Disc. since 1962</u>
71. South Yemen	0	X	X	0	X	X	No Encouragement
72. Syria	0	X	X	0	X	X	<u>Disc. since 1956</u>
73. Turkey	43	X	X	310	X	X	<u>Disc. since 1940</u>
74. Yemen	0	0	X	0	X	X	No Encouragement
<b>FAR EAST</b>							
75. Afghanistan	0	X	X	0	X	X	No Encouragement
76. Bangladesh	5	X	X	5	X	X	Gas Disc. (since 1959)
77. Burma	9	X	X	37	X	X	Small Disc. (old)
78. Cambodia	0	0	X	3	X	X	No Disc. (shows)
79. Fiji	0	0	X	0	X	X	No Encouragement
80. India	0	X		28	X		<u>Disc. since 1889</u>

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EXPLORATION ACTIVITY IN NON-OPEC  
DEVELOPING COUNTRIES

<u>Country</u>	<u>Year 1976</u>			<u>1967-1976</u>			<u>Results of Drilling</u>
	<u>Exploratory Wells</u>	<u>Seismic</u>	<u>Acreage</u>	<u>Exploratory Wells</u>	<u>Seismic</u>	<u>Acreage</u>	
<u>FAR EAST (continued)</u>							
81. Malaysia (incl. Brunei)	21	X	X	185	X	X	<u>Disc. since 1911</u>
82. Maldives	0	0	X	0	X	X	No Encouragement
83. New Hebrides	0	0	0	0	0	X	No Encouragement
84. New Zealand	7	X	X	54	X	X	Gas Disc. since 1959
85. Pakistan	1	X	X	50	X	X	<u>Disc. since 1937</u>
86. Papua-New Guinea	2	X	X	19	X	X	No Disc. (shows)
87. Philippines	8	X	X	82	X	X	No Disc. (shows)
88. South Korea	0	0	X	7	X	X	No Encouragement
89. Sri Lanka	3	X	X	3	X	X	No Encouragement
90. Taiwan	10	X	X	120	X	X	Small Disc.
91. Thailand	17	X	X	70	X	X	Gas Disc. 1973 (minor oil pre-1967)
92. Tonga	0	0	X	0	X	X	No Encouragement
93. Vietnam	0	X	0	4	X	X	No Disc. (shows)
TOTAL	616			6501			

NON-OPEC DEVELOPING COUNTRIES  
WHERE NO EXPLORATION ACTIVITY, 1967-1976

<u>Country</u>	
1.	El Salvador
2.	Granada
3.	Botswana
4.	Cape Verde Islands
5.	Comoros
6.	Djibouti
7.	Malawi
8.	Rhodesia
9.	Rwanda
10.	Seychelles
11.	Swaziland
12.	Upper Volta
13.	Zambia
14.	Bhutan
15.	Laos
16.	Nauru
17.	Nepal
18.	Samoa
19.	Solomon Islands
20.	Singapore

RECONCILIATION WITH AID LIST OF 88 DEVELOPING NATIONS

AID LIST INCLUDES

1. Brunei (separate from Malaysia)
2. Greece
3. Spain
4. Yugoslavia

AID LIST EXCLUDES

1. Bahamas
2. Barbados
3. Belize
4. Bhutan
5. Cambodia
6. Comoros
7. Cape Verde Islands
8. Djibouti
9. French Guiana
10. Grenada
11. Guinea-Bissau
12. Israel
13. Laos
14. Leeward-Windward Islands
15. Maldives
16. Nauru
17. Netherlands Antilles
18. New Hebrides
19. New Zealand
20. Puerto Rico
21. Rhodesia
22. Samoa
23. SaoTome & Principe
24. Seychelles
25. Solomon Islands
26. South Africa
27. S.W. Africa (Namibia)
28. South Yemen
29. Tonga
30. Vietnam

